MECHANICAL, THERMAL AND CHARACTERIZATION OF CHITOSAN, NANO PRECIPITATED CALCIUM CARBONATE SINGLE AND HYBRID FILLER/ POLY(VINYL CHLORIDE) COMPOSITES

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To my beloved husband, parent and all my family members

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ABSTRACT

The aim of this study is to investigate the mechanical, thermal and characterization of chitosan, nano precipitated calcium carbonate single and hybrid filler/ poly (vinyl chloride) (PVC) composites. Graft copolymerization of poly (methyl methacrylate) (PMMA) onto chitosan (CS) was carried out under nitrogen atmosphere by free radical initiation in aqueous medium. Hydrogen peroxide (H_2O_2) and ferrous ions were used as a redox initiator/co-catalyst system. The PMMA homopolymer formed during the reaction was removed from the graft copolymer by extraction using acetone. The presence of PMMA functional groups in Fourier transform infra red (FTIR) spectra of grafted CS at peak 1731 cm^{-1} proved that the grafting process was successfully done. The single fillers (grafted CS, CS and nano-precipitated calcium carbonate (NPCC)) and hybrid fillers ((CS (2 phr)/NPCC (4 phr) and CS (4 phr)/NPCC (2 phr)) were pre-mixed with PVC using a high speed mixer. The dried blend formulations were milled into sheets using a two roll mill at temperature of 170 ^oC and then hot pressed at temperature of 175 ^oC. The tensile, flexural, impact strength and elongation at break of hybrid composites were increased compared to single fillers. Differences in surface morphology between the single composites and hybrid composites were observed. The hybrid PVC composites had better thermal stability than single composites. The increased of water resistance of the hybrid composites proved good filler-matrix interaction. Overall, the study showed that the hybrid PVC composites had good mechanical and thermal properties compared to the single filler PVC composites. PVC/CS (4 phr)/NPCC (2 phr) had reached a balanced properties in mechanical as well as thermal properties.

ABSTRAK

Tujuan kajian ini adalah untuk mengkaji mekanikal, terma dan pencirian kitosan, nano termendak kalsium karbonat berpengisi tunggal dan hibrid komposit poli (vinil klorida) (PVC). Pengkopolimeran cangkuk poli (metil metakrilat) (PMMA) ke atas kitosan telah dijalankan di bawah pemulaan radikal bebas di dalam medium akues. Hidrogen peroksida (H_2O_2) dan ion-ion ferus telah digunakan sebagai sistem redoks pemula/pembantu mangkin. Homopolimer PMMA terbentuk semasa tindakbalas dipisahkan daripada polimer cangkuk melalui kaedah pengekstrakan dengan menggunakan aseton. Kehadiran kumpulan berfungsi PMMA pada spektra infra merah transformasi Fourier (FTIR) kitosan tercangkuk pada puncak 1731 cm^{-1} membuktikan bahawa proses pengcangkukan telah berjaya dilakukan. Kandungan pengisi tunggal (pengcangkukan kitosan, kitosan dan NPCC) dan hibrid pengisi ((CS (2 phr)/NPCC (4 phr) dan (CS (4 phr)/NPCC (2 phr)) telah di pra-campurkan dengan PVC menggunakan sebuah pengisar berkelajuan tinggi. Formulasi adunan kering kemudiannya dijadikan kepingan menggunakan pengguling berkembar pada suhu 170 ^oC dan dimampatkan pada suhu 175 ^oC. Kekuatan tegangan, lenturan, hentaman dan pemanjangan pada titik putus komposit PVC hibrid lebih tinggi berbanding pengisi tunggal. Perbezaan morfologi permukaan antara komposit tunggal dan komposit hibrid telah diperhatikan. Komposit PVC hibrid mempunyai kestabilan terma yang lebih baik berbanding komposit berpengisi tunggal. Peningkatan rintangan air komposit berpengisi hibrid membuktikan interaksi pengisi-matrik yang baik. Secara keseluruhannya, kajian menunjukkan bahawa komposit PVC berpengisi hibrid menunjukkan sifat-sifat mekanikal dan terma yang lebih baik berbanding komposit PVC berpengisi tunggal. PVC/CS (4 phr)/NPCC (2 phr) telah mencapai keseimbangan pada sifat-sifat mekanikal serta terma.